TEST REPORT

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DRY MAGNETIC SEPARATION
of
EASTERN COALS

by
Eriez Magnetics Staff

Work on the project was conducted under the auspices of Canada Centre for Mineral and Energy Technology, Energy Mines and Resources Canada.

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A B S T R A C T

An extensive series of tests were conducted to study the magnetic separation of three eastern Canadian coals using high gradient magnetic separation. Parameters investigated were wet and dry separation, particle size distribution, feed flowrate, matrix type, and magnetic field strength.

Both wet and dry separation produced coals with ash contents in the range of 2-18% with recoveries of combustables in the range of 70-90%. Sulfur rejection using a 2% S feed coal was between 55 and 72% by wet separation and 45 and 71% by dry methods. Test results have been analyzed and are discussed in terms of the Gaudin Selectivity Index to facilitate comparison of data. A correlation was found between the Selectivity Index and the magnetic volume loading of the matrix which ranged from .9-5%.

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ERIEZ MAGNETICS®

Technical Center
REPORT OF TEST

Date: SEPTEMBER 25, 1985 Research Request: #85-012

Test Made For: CANMET

1.0 TITLE:

Dry Magnetic Separation of Eastern Coal.

2.0 INTRODUCTION:

CANMET is studying the removal of ash and pyrite from eastern Canadian coals. CANMET wished to explore both wet and dry high gradient magnetic separation on the Eriez Laboratory Superconducting HGMS. Gilles Mathieu and Mickey Raicevic of CANMET visited Eriez together or individually in January, February, April and August to pursue the test program and review the results.

2.1 Objective --

To test the three coals varying the following parameters -- field strength, size fraction, flow velocity, and matrix in both wet and dry separation schemes.

2.2 Samples --

The coals to be tested were Petro Canada-Kipp, Devco-Lingan, and Devco-Prince. The Kipp coal had a high ash content ($\sim 28\%$) and a low sulfur content ($< 0.5\%$). The Lingan coal had a medium ash content ($\sim 24\%$) and a modest sulfur content ($\sim 2\%$). The Prince coal also had a medium ash content with a high sulfur content ($\sim 5\%$). Those samples to be treated wet were wet screened into three size fractions, 70 x 140 mesh, 140 x 325 mesh and minus 325 mesh. Those samples to be treated dry were dry screened

into three size fractions, 30 x 70 mesh, 70 x 150 mesh and minus 150 mesh. Later, the minus 150 mesh fractions were rescreened into 150 x 400 mesh fractions. This was done because the minus 400 mesh coal acted as a binder and prevented good dispersion of the dry coal.

3.0 TEST PROCEDURES:

3.1 Wet Tests --

The HGMS Separator was operated in the downflow mode. Three valves were used to control slurry flow. A single valve at the top prevented slurry mix from prematurely entering the HGMS. One of the two valves at the bottom was used as a flow regulator and was kept at a preset position. The second valve at the bottom was used to hold water in the separator before testing began.

Coal slurry was mixed in a conical tank directly above the top valve. When slurried, the top and bottommost valves were opened allowing slurry to flow at the preset rate. The rates used for wet testing were 15.5, 23.3, 26, 35 and 46.6 mm/sec.

Flow rates through the separator were measured at constant head with water only. It was found necessary to prevent vortex formation in the feed reservoir when measuring flow rates and when performing tests. Entrained air tended to increase the flow rate through the matrix. At the same time, this entrained air tended to reduce the weight of magnetics retained, probably due to the high drag resulting from passage of air-water interfaces over the matrix elements.

The magnetic field strength required for each test was set before any valves were opened. The fields chosen for both wet and dry testing were 1.5, 2.5 and 5.0 tesla.

Three matrices were used for the wet tests. Each matrix was built up from 98 mm discs of expanded metal on a threaded rod. The first matrix used spacers between the discs. Disc spacing was on approximately 7 mm centers. Discs for the other two matrices used in the wet tests were not spaced apart. The expanded metals used were Type 430 Stainless MEX (1/4 #18) and FEX (Galvanized Plaster Lath). Descriptions of the matrices used are given in Figure #1.

3.2 Dry Tests --

Again, the HGMS was operated in a downflow mode. Feed to the separator was mixed and entrained in the airstream using a funnel at the top of the separator. An expansion chamber fitted with a particulate filter was placed just below the separator. The rate of airflow through the filter was measured with a rotameter and regulated with a valve. Airflow was provided by a vacuum pump attached to the regulating valve. Airflow rates could be varied to provide a range of nominal air velocities within the matrix. These nominal velocities ranged between 150 and 364 feet per minute.

Removal of magnetics upon completion of each test normally required the maximum airflow rate.

In order to achieve the high air velocities required for these tests using the best available vacuum pump, a 2 inch diameter chamber was required. The matrices were therefore

constructed from 48 mm discs of expanded metal. These discs were spaced using 4 mm diameter aluminum rings. Two matrices were used for the dry tests. The first used Type 430 stainless MEX, while the second used galvanized SFEX, (3/32, #26). These matrices are also described in Figure #1.

3.3 Analyses --

All test products were returned to CANMET for ash and sulfur analyses.

4.0 EVALUATION:

A summary of all data collected or calculated is given in Figures #2 through #7. These tables show the size ranges tested, the original test number, the magnetic field, the flow velocity, the feed weight, the matrix loading, the weight distribution, ash analyses, ash distributions, either sulfur analyses and distributions or combustible analyses and distributions, and finally the Gaudin Selectivity Index.

4.1 Matrix Loadings --

Matrix loadings were calculated in two ways. The first loading is the ratio of the magnetic mass to the matrix mass expressed as a percentage. The second loading is the ratio of the magnetic volume to the matrix void volume expressed as a percentage. The matrix volume calculated was the effective matrix volume; i.e., space filling less support structures. From this the volume of the matrix discs was subtracted yielding the void volume. Matrix masses and void volumes are presented in Figure #1.

The magnetic volume was calculated using the following equation:

$$\text{Magnetic Volume} = \frac{(\text{Feed Weight}) \times (\%\ \text{Magnetic})}{10000} \times \left(\frac{[1-\text{Ash}\%]}{1.3} + \frac{\text{Ash}\ \%}{2.65} \right) \quad (1)$$

This equation does not account for the volume due to sulfur in sulfates and pyrites except for the iron reporting to the ash. It is expected that corrections to the calculated volumes would be less than 5% for most of the data.

The mass loading ranged between 1.7% and 11.4%. The bulk of the loadings were between 3% and 5%. The volumetric loadings were lower than the mass loadings. They ranged between 0.89% and 4.99%. The bulk of the tests were run at volume loadings of 1.8% to 3.5%.

While these loadings seem to be light, they are in the general range used commercially by wet high intensity magnetic separators. Further, data given by Bolsaitis, et al (IEEE Trans. Magn., MAG-18, 1677 (1982)), indicates that volumetric loading will level off in the range between 0.9% and 3.8%, depending upon field strength, for a given matrix.

4.2 Selectivity Index --

The Gaudin Selectivity Index (S.I.) was calculated from the ash and sulfur values using the following formula:

$$S.I. = \left(\frac{t\ (100-c)}{c\ (100-t)} \right) \quad 0.5 \qquad (2)$$

Kipp Coal: c = non-magnetic ash percent
t = magnetic ash percent

Devco Coals: (Prince & Lingan)
c = non-magnetic ash % + 1.6 x non-magnetic sulfur %
t = magnetic ash % + 1.6 x magnetic sulfur %

The S.I. values for these tests ranged from 0.6 to 8.9. In general, the selectivity was higher for the dry tests than for the wet. It should be noted, however, that the dry tests could not tolerate minus 400 mesh coal.

A second trend was that the intermediate-sized fractions gave a higher S.I. than either the coarse or the fine fractions. Thirdly, the fine fractions gave the poorest S.I.'s.

The S.I.'s seemed to show some dependence on the volumetric matrix loading. Some clustering of data indicated that the plus 325 mesh Prince and Lingan coals reacted about the same to wet magnetic separation. Both coals were relatively sensitive to volumetric loading below 4%. Above a 4% loading the rate of change was relatively slow. If the demands of the coal separation do not require S.I.'s greater than 4, then loading and throughput could be increased.

The Kipp coal was relatively insensitive to loading for all sizes in the wet tests. However, its S.I.'s were barely better in the coarse sizes than the S.I.'s for the minus 325 mesh fractions of the other coals.

The dry separation S.I.'s tended to fit into a broad band. S.I.'s above 4 were relatively dependent upon loading. Below 4 the S.I.'s were relatively insensitive to loading.

5.0 CONCLUSIONS:

The ratio of magnetics volume to the volume of matrix-free space (voids) correlates well with the Selectivity Index, even when the matrix changes.

The ratio of magnetics weight collected to the matrix weight does not correlate well with the Selectivity Index.

High Selectivity Indexes are found at light loadings where there is good liberation of ash and coal.

The Selectivity Index was found to change relatively slowly with loading once a relatively low index was reached. Therefore, volumetric efficiency could be enhanced fairly rapidly with only a moderate loss in product quality.

Flow velocity and field strength could be balanced to provide an optimum Selectivity Index for a given matrix.

6.0 SUMMARY:

Three eastern Canadian coals were tested for separation on a Laboratory Superconducting HGMS. The parameters investigated were wet and dry separations, matrix, field strength, flow rate and size distribution. Results are presented for 92 tests from 143 completed. All samples were assayed for ash. The two high sulfur coals were also assayed for sulfur. Matrix loadings and Gaudin Selectivity Indexes were computed and are included in the test data tables.

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JAW/jaj

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Figure #1

MATRIX DESCRIPTIONS

MATRIX NO.	MATRIX MATERIAL	PIECES #	LENGTH mm	DIA. mm	CENTRAL ROD mm	SPACER RING ID / Tk	WEIGHT g	VOLUME ml	VOIDS ml
1	SMEX (1)	56	388	98.4	7	--	2264	2936	2644
2	MEX	124	364	98.4	7	--	4990	2753	2109
3	FEX	151	397	98.4	7	--	2041	3004	2743
4	SMEX (2)	73	481	47.6	--	37.6/4.35	731	717	623
5	SSFX	85	474	47.6	--	37.6/4.35	385	681	632

SMEX = SPACED MEDIUM EXPANDED METAL (1/4 #18) 430 STAINLESS

MEX = MEDIUM EXPANDED METAL (1/4 #18) 430 STAINLESS

FEX = FINE EXPANDED METAL (PLASTER LATH) GALVANIZED MILD

SSFEX = SPACED SUPER FINE EXPANDED METAL (3/32 #26) GALVANIZED MILD

STAINLESS $\rho = 7.75$

GALVANIZED MILD STEEL $\rho = 7.83$

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Figure #2

PETRO CANADA (KIPP) COAL

WET HGMS

SIZE RANGE	0.2 × 0.1 mm (65 × 150 mesh)				0.1 × 0.4 mm (150 × 325 mesh)			0.4 × 0.0 mm -325 mesh			
TEST NUMBER	21	24	27	22	26	25	E	62	63	61	64
MATRIX	← SMEX 1 →				← SMEX 1 →			← FEX →			
MAGNETIC FIELD (T)	1.5	2.5	5.0	2.5	1.5	2.5	5.0	1.5	2.5	5.0	2.5
FLOW VELOCITY (mm/sec)	47	47	47	35	47	47	47	35	35	35	23
FEED AMOUNT (g)	206	273	254	319	524	373	449	298	326	438	341
MATRIX LOADING											
(Weight Ratio) %	1.84	3.09	4.13	4.73	5.16	4.38	6.96	2.34	3.08	5.82	5.13
(Volume-Void Ratio) %	0.95	1.67	2.31	2.64	2.31	2.01	3.39	0.93	1.24	2.42	2.17
WEIGHT DISTRIBUTION											
MAGS	20.2	25.6	36.8	33.6	22.3	26.6	35.1	16.0	19.3	27.1	30.7
NON-MAGS	79.8	74.4	63.2	66.4	77.7	73.4	64.9	84.0	80.7	72.9	69.3
ASH ANALYSIS											
MAGS	42.4	35.1	29.4	29.8	63.0	59.4	51.3	59.9	58.0	53.7	51.4
NON-MAGS	8.6	7.5	7.4	7.0	15.8	14.4	19.9	43.2	43.2	42.4	43.4
FEED	15.0	15.0	15.0	15.0	26.4	26.4	26.4	45.9	45.9	45.9	45.9
ASH DISTRIBUTION %											
MAGS	55.5	61.7	69.8	68.3	53.4	59.9	68.2	20.9	24.0	32.6	34.4
NON-MAGS	44.5	38.3	30.2	31.7	46.6	40.1	31.8	79.1	76.0	67.4	65.4
COMBUSTIBLE (100-Ash)											
MAGS	57.6	64.9	70.6	70.2	37.0	40.6	48.7	40.1	42.0	46.3	48.6
NON-MAGS	91.4	92.5	92.6	93.0	84.2	85.6	87.1	56.3	57.0	57.6	56.6
FEED	84.6	85.4	84.5	84.7	73.6	73.6	73.6	53.7	54.2	54.2	54.2
COMB. DISTRIBUTION %											
MAGS	13.8	19.4	20.4	27.1	12.0	14.7	23.2	11.9	15.0	23.2	27.6
NON-MAGS	86.2	80.6	79.6	72.9	88.0	85.3	76.8	88.1	85.0	76.8	72.4
GAUDIN SELECTIVITY INDEX	2.8	2.6	3.0	2.4	2.9	2.9	2.7	1.4	1.3	1.3	1.2

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Figure #3

PETRO CANADA (KIPP) COAL
DRY HGMS

SIZE RANGE	0.6 x 0.2 mm (28 x 65 mesh)				0.2 x 0.1 mm (65 x 150 mesh)								0.1 x 0.04 mm (150 x 400 mesh)					
TEST NUMBER	90	87	88	89	91	93	94	95	103	104	105	106	128	127	126	123	124	125
MATRIX	SMEX 2				SMEX 2				SSFX				SSFX					
MAGNETIC FIELD (T)	1.5	1.5	2.5	5.0	1.5	1.5	2.5	5.0	1.5	2.5	5.0	2.5	1.5	1.5	2.5	2.5	5.0	5.0
FLOW VELOCITY (ft/min)	364	300	300	300	200	250	250	250	250	250	250	250	200	250	250	300	300	364
FEED AMOUNT (g)	94	98	103	106	95	106	98	104	98	103	106	96	98	97	99	94	97	99
MATRIX LOADING (Weight Ratio) %	2.23	3.32	4.42	6.47	3.73	2.89	3.71	4.65	5.84	7.04	10.21	7.79	8.29	4.81	7.48	4.70	7.12	5.17
(Volume-Void Ratio) %	1.24	1.97	2.73	4.30	2.33	1.65	2.23	2.91	1.74	2.15	3.43	2.50	3.05	1.65	2.67	1.55	2.48	1.69
WEIGHT DISTRIBUTION																		
MAGS	17.3	24.8	31.4	44.6	28.7	19.9	27.7	32.7	23.0	26.3	37.1	31.2	32.6	19.1	29.1	19.3	28.3	20.1
NON-MAGS	82.7	75.2	68.6	55.4	71.3	80.1	72.3	67.3	77.0	73.7	62.9	68.8	67.4	80.9	70.9	80.7	71.7	79.9
ASH ANALYSIS																		
MAGS	75.3	66.9	62.4	51.8	60.8	71.9	65.2	60.3	71.3	67.8	55.7	61.3	42.0	53.5	46.8	57.9	50.0	59.1
NON-MAGS	18.5	15.6	12.7	9.4	12.5	15.1	11.5	9.9	13.0	11.6	9.1	10.6	11.7	14.0	11.2	13.0	10.4	12.1
FEED	28.3	28.3	28.3	28.3	26.4	26.4	26.4	26.4	26.4	26.4	26.4	26.4	21.6	21.6	21.6	21.6	21.6	21.6
ASH DISTRIBUTION %																		
MAGS	46.0	58.6	69.2	81.6	66.1	54.2	68.4	74.7	62.0	67.6	78.3	72.4	63.4	47.4	63.2	52.0	65.5	55.1
NON-MAGS	54.0	41.4	30.8	18.4	33.9	45.8	31.6	25.3	38.0	32.4	21.7	27.6	36.6	52.6	36.8	48.0	34.5	44.9
COMBUSTIBLE (100-Ash)																		
MAGS	24.7	33.1	37.6	48.2	39.2	28.1	34.8	39.7	28.7	32.2	44.3	38.7	58.0	46.5	53.2	42.1	50.0	40.9
NON-MAGS	81.6	84.4	87.3	90.6	87.5	84.9	88.5	90.1	87.0	88.4	90.9	89.4	88.3	86.0	88.8	87.0	89.6	87.9
FEED	71.7	71.7	71.7	71.7	73.6	73.6	73.6	73.6	73.6	73.6	73.6	73.6	78.4	78.4	78.4	78.4	78.4	78.4
COMB. DISTRIBUTION %																		
MAGS	6.0	11.5	16.5	30.0	15.3	8.0	13.1	17.6	9.0	11.5	22.3	16.1	24.1	11.3	19.7	10.4	18.0	10.5
NON-MAGS	94.0	88.5	83.5	70.0	84.7	92.0	86.9	82.4	91.0	88.5	77.7	83.6	75.9	88.7	80.3	89.6	82.0	89.5
GAUDIN SELECTIVITY INDEX	3.6	3.3	3.4	3.2	3.2	3.7	3.8	3.7	4.1	4.0	3.5	3.7	2.3	2.7	2.6	3.1	2.9	3.2

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RR #85-012

Figure #4

DEVCO (LINGAN) COAL
WET HGMS

SIZE RANGE	0.2 x 0.1 mm (65 x 150 mesh)					0.1 x 0.04 mm (150 x 325 mesh)						0.4 x 0 mm (-325 mesh)				
TEST NUMBER	19	17	15	16	20	33	30	42	31	32	46	59	56	55	57	60
MATRIX	← SMEX 1 →					← MEX →						← FEX →				
MAGNETIC FIELD (T)	1.5	1.5	2.5	5.0	5.0	1.5	1.5	2.5	5.0	5.0	5.0	1.5	1.5	2.5	5.0	5.0
FLOW VELOCITY (mm/sec)	16	23	23	23	35	16	26	35	26	35	47	23	35	35	35	47
FEED AMOUNT (g)	528	533	490	516	512	417	409	427	424	405	352	501	417	521	445	397
MATRIX LOADING (Weight Ratio) %	7.35	6.17	6.69	7.93	6.99	2.99	2.78	2.69	3.64	2.89	2.23	4.96	2.96	4.90	5.69	4.94
(Volume-Void Ratio) %	3.53	2.90	3.17	3.93	3.34	3.92	3.63	3.36	4.99	3.78	2.73	1.79	1.02	1.75	2.13	2.08
WEIGHT DISTRIBUTION																
MAGS	31.5	26.7	30.9	34.8	30.9	35.8	33.9	31.4	42.8	35.6	31.6	20.2	14.5	19.2	26.1	25.4
NON-MAGS	68.5	73.3	69.1	65.2	69.1	64.2	66.1	68.6	57.2	64.4	68.4	79.2	85.5	80.8	73.9	74.6
ASH ANALYSES																
MAGS	53.1	58.8	54.9	48.8	53.8	54.9	55.3	61.9	48.4	55.2	64.2	72.2	77.6	73.8	67.7	70.5
NON-MAGS	2.4	2.9	3.1	2.3	2.2	4.3	4.6	4.8	3.8	4.2	3.6	31.3	32.9	31.2	29.4	(28.8)*
FEED	18.4	17.8	19.1	18.5	17.1	22.4	22.9	22.7	22.2	22.4	22.7	39.4	39.4	39.4	39.4	39.4
ASH DISTRIBUTION %																
MAGS	91.1	88.1	88.8	81.9	91.1	87.7	86.0	85.6	90.5	87.9	89.2	37.0	28.6	36.0	44.8	45.4
NON-MAGS	8.9	11.9	11.2	8.1	8.9	12.2	14.0	14.5	9.5	12.1	10.8	63.0	71.4	64.0	55.2	54.6
SULFUR ANALYSES																
MAGS	3.0	2.8	2.8	2.8	2.9	3.8	4.1	4.1	3.3	3.5	4.5	2.61	2.59	2.74	2.69	--
NON-MAGS	1.2	1.3	1.2	1.1	1.2	1.0	0.9	1.1	0.9	1.1	0.8	1.15	1.25	1.13	1.00	--
FEED	1.7	1.7	1.7	1.7	1.7	2.0	2.0	2.0	2.0	2.0	2.0	1.44	1.44	1.44	1.44	1.44
SULFUR DISTRIBUTION %																
MAGS	54.3	44.2	51.6	57.6	52.8	67.9	70.0	63.0	73.9	64.4	72.2	36.6	26.1	36.6	48.8	--
NON-MAGS	45.7	55.8	48.4	42.4	47.2	32.1	30.0	37.0	26.1	35.6	27.8	63.4	73.9	63.4	51.2	--
GAUDIN SELECTIVITY INDEX COMBUSTIBLE (100-Ash-1.6 S)	5.5	5.7	5.3	5.2	5.7	5.0	5.0	5.6	4.6	4.9	7.0	2.6	2.9	2.7	2.4	--

* CALCULATED

CANMET
RR #85-012
Figure #5

DEVCO (LINGAN) COAL
DRY HGMS

SIZE RANGE	0.6 x 0.2 mm (28 x 65 mesh)				0.2 x 0.1 mm (65 x 150 mesh)							0.1 x 0.04 mm (150 x 400 mesh)				
TEST NUMBER	69	96	71	72	75	76	77	78	100	101	102	131	132	130	133	134
MATRIX	← SMEX 2 →				← SMEX 2 →				← SSFX →			← SSFX →				
MAGNETIC FIELD (T)	1.5	1.5	2.5	5.0	1.5	2.5	5.0	2.5	1.5	2.5	5.0	1.5	1.5	2.5	2.5	5.0
FLOW VELOCITY (ft/min)	300	364	364	364	200	200	200	150	200	200	200	300	364	300	364	364
FEED AMOUNT (g)	96	95	103	97	94	104	96	106	90	91	105	96	99	101	95	94
MATRIX LOADING (Weight Ratio) %	3.58	3.53	4.25	4.57	2.24	3.13	3.34	5.34	4.73	5.79	8.16	7.27	3.58	8.75	5.09	6.08
(Volume-Void Ratio) %	1.94	1.86	2.33	2.66	1.20	1.89	2.13	3.80	1.41	1.88	2.83	2.50	1.08	3.09	1.53	1.90
WEIGHT DISTRIBUTION																
MAGS	27.3	27.2	30.2	34.4	17.5	22.0	25.4	36.8	20.2	24.5	29.9	29.2	13.9	33.4	20.6	24.9
NON-MAGS	72.7	72.8	69.8	65.6	82.5	78.0	74.1	63.2	79.8	75.5	70.1	70.8	86.1	66.6	79.4	75.1
ASH ANALYSES																
MAGS	78.4	82.1	77.4	69.7	79.3	64.3	57.0	41.3	70.8	60.1	51.1	52.6	70.5	49.0	68.2	65.4
NON-MAGS	7.4	6.1	4.9	4.2	3.9	3.8	3.2	3.0	3.5	3.1	2.6	5.3	10.8	4.1	6.5	3.7
FEED	26.8	26.8	26.8	26.8	17.1	17.1	17.1	17.1	17.1	17.1	17.1	19.1	19.1	19.1	19.1	19.1
ASH DISTRIBUTION %																
MAGS	79.9	83.4	87.2	89.7	81.2	82.7	86.2	88.9	83.7	86.1	89.3	80.4	51.3	85.7	73.1	85.4
NON-MAGS	20.1	16.6	12.8	10.3	18.8	17.3	13.8	11.1	16.3	13.9	10.7	19.6	48.7	14.3	26.9	14.6
SULFUR ANALYSES																
MAGS	2.1	2.1	1.8	2.0	3.2	3.2	3.0	2.8	3.2	3.5	3.2	2.1	3.2	2.2	2.5	2.5
NON-MAGS	1.6	1.4	1.7	1.5	1.6	1.5	1.5	1.3	1.5	1.5	1.3	1.9	1.7	1.8	1.7	1.7
FEED	1.7	1.7	1.7	1.7	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9
SULFUR DISTRIBUTION %																
MAGS	33.1	32.4	31.4	41.3	30.2	37.7	40.5	55.6	35.2	47.0	51.2	31.5	23.5	38.0	27.6	32.8
NON-MAGS	66.9	67.6	68.6	58.7	69.8	62.3	59.5	44.4	64.8	53.0	48.8	68.3	76.5	62.0	72.4	67.2
GAUDIN SELECTIVITY INDEX																
COMBUSTIBLE (100-Ash-1.6 S)	6.4	8.0	7.0	6.2	8.9	5.9	5.2	4.0	7.1	5.7	5.1	3.7	4.5	3.8	5.1	5.7

CANMET
RR #85-012
Figure #6

DEVCO (PRINCE) COAL
WET HGMS

SIZE RANGE	0.2 x 0.1 mm (65 x 150 mesh)					0.1 x 0.04 mm (150 x 325 mesh)						0.4 x 0 mm (-325 mesh)				
TEST NUMBER	23	11	10	12	9	40	39	37	38	41	49	53	52	50	51	54
MATRIX	← SMEX 1 →					← MEX →					FEX	← FEX →				
MAGNETIC FIELD (T)	1.5	1.5	2.5	5.0	5.0	1.5	1.5	2.5	5.0	5.0	2.5	1.5	1.5	2.5	5.0	5.0
FLOW VELOCITY (mm/sec)	16	23	23	23	47	16	23	23	23	35	23	16	23	23	23	35
FEED AMOUNT (g)	681	677	639	669	655	498	484	476	484	487	476	448	532	505	473	491
MATRIX LOADING																
(Weight Ratio) %	6.68	4.18	4.51	6.44	3.88	2.54	1.94	2.08	3.09	2.24	4.92	4.38	3.02	5.34	7.69	4.36
(Volume-Void Ratio) %	3.37	1.92	2.10	3.21	1.77	3.55	2.58	2.87	4.54	3.12	2.09	1.80	1.20	2.26	3.35	1.79
WEIGHT DISTRIBUTION																
MAGS	22.2	14.0	16.0	21.8	13.4	25.4	20.0	21.8	31.9	23.0	21.1	19.8	11.6	21.6	33.2	18.1
NON-MAGS	77.8	86.0	84.0	78.2	86.6	74.6	80.0	78.2	68.1	77.0	78.9	80.2	88.4	78.4	66.8	81.9
ASH ANALYSES																
MAGS	46.0	59.7	58.1	47.6	60.1	45.4	52.5	47.4	37.9	46.7	50.4	54.0	60.4	51.3	46.8	54.5
NON-MAGS	5.4	7.2	6.4	5.1	7.1	3.6	4.3	3.9	2.8	4.1	4.3	32.5	33.7	32.8	31.9	32.9
FEED	14.4	14.6	14.7	14.4	14.2	14.2	13.9	13.4	14.0	13.9	14.0	36.8	36.8	36.8	36.8	36.8
ASH DISTRIBUTION %																
MAGS	70.8	57.4	63.1	72.2	56.7	81.1	75.3	77.2	86.4	77.3	75.8	29.1	19.0	30.1	42.2	26.8
NON-MAGS	29.2	42.6	36.9	27.8	43.3	18.9	24.7	22.8	13.6	22.7	24.2	70.9	81.0	69.9	57.8	73.2
SULFUR ANALYSES																
MAGS	11.2	13.3	12.3	11.0	14.5	11.8	13.9	12.7	10.5	12.8	14.7	6.9	6.5	6.1	5.5	7.5
NON-MAGS	2.6	3.1	2.8	2.7	3.0	2.4	2.6	2.5	2.0	2.3	2.0	3.6	3.9	3.7	3.5	3.6
FEED	4.5	4.5	4.4	4.5	4.5	4.8	4.8	4.7	4.7	4.7	4.2	4.3	4.2	4.2	4.2	4.3
SULFUR DISTRIBUTION %																
MAGS	55.1	41.1	44.7	53.2	42.8	62.6	57.2	58.6	71.4	62.4	66.2	32.1	18.0	31.2	43.9	31.5
NON-MAGS	44.9	58.9	55.3	46.8	57.2	37.4	42.8	41.4	28.6	37.6	33.7	67.9	82.0	68.8	56.1	68.4
GAUDIN SELECTIVITY INDEX COMBUSTIBLE (100-Ash-1.6 S)	4.1	5.5	5.4	4.2	6.1	4.7	5.7	4.9	4.3	4.9	5.9	1.7	1.9	1.6	1.4	1.8

CANMET
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Figure #7

DEVCO (PRINCE) COAL
DRY HGMS

SIZE RANGE	0.6 x 0.2 mm (28 x 65 mesh)				0.2 x 0.1 mm (65 x 150 mesh)				0.1 x 0.04 mm (150 x 400 mesh)									
TEST NUMBER	80	E	81	82	83	84	85	86	97	98	99	139	136	138	137	141	140	
MATRIX	SMEX 2				SMEX 2				SSFX			SSFX						
MAGNETIC FIELD (T)	1.5	1.5	2.5	5.0	1.5	2.5	5.0	2.5	1.5	2.5	5.0	2.5	2.5	3.5	3.5	5.0	5.0	
FLOW VELOCITY (ft/sec)	200	300	300	300	200	200	200	150	200	200	200	200	250	200	250	250	300	
FEED AMOUNT (g)	106	100	95	106	97	105	95	105	103	94	103	99	98	102	99	100	100	
MATRIX LOADING (Weight Ratio) %	5.44	2.35	2.78	5.13	1.70	2.23	2.97	3.90	4.21	4.96	4.34	5.69	3.56	11.40	3.66	6.34	2.78	
(Volume-Void Ratio) %	3.87	1.33	1.78	3.47	1.01	1.35	1.89	2.68	1.30	1.58	2.36	2.14	1.25	4.64	1.27	2.37	0.89	
WEIGHT DISTRIBUTION																		
MAGS	37.5	17.2	21.4	35.4	12.8	15.5	22.8	27.1	15.7	20.3	25.9	22.1	14.0	43.0	14.2	24.4	10.7	
NON-MAGS	62.5	82.8	78.6	64.6	87.2	84.5	77.2	72.9	84.3	79.7	74.1	77.9	86.0	57.0	85.8	75.6	89.3	
ASH ANALYSES																		
MAGS	41.6	72.7	57.4	49.4	65.8	64.9	57.4	46.7	67.3	62.6	53.5	38.7	48.6	26.1	50.8	39.0	61.9	
NON-MAGS	11.7	15.1	13.4	9.6	11.6	10.0	7.0	8.0	9.4	7.2	6.3	8.2	9.4	6.4	8.9	7.1	9.2	
FEED	22.9	25.0	22.8	23.7	18.5	18.5	18.5	18.5	18.5	18.4	18.5	14.9	14.9	14.9	14.9	14.9	14.8	
ASH DISTRIBUTION %																		
MAGS	68.1	50.0	53.8	73.8	45.4	54.4	70.8	68.4	57.1	68.9	74.8	57.3	45.7	75.5	48.6	63.9	44.6	
NON-MAGS	31.9	50.0	46.2	26.2	54.6	45.6	29.2	31.6	42.9	31.1	25.2	42.7	54.3	24.5	51.4	36.1	55.4	
SULFUR ANALYSES																		
MAGS	3.4	3.6	4.0	4.3	6.0	6.1	7.1	6.3	7.4	8.1	7.8	7.7	8.3	6.1	8.3	8.3	8.9	
NON-MAGS	3.7	3.6	3.5	3.1	4.4	4.3	3.9	4.0	4.1	3.7	3.4	3.3	3.6	3.0	3.6	3.1	3.7	
FEED	3.6	3.6	3.6	3.5	4.6	4.6	4.6	4.6	4.6	4.6	4.6	4.3	4.3	4.3	4.3	4.4	4.3	
SULFUR DISTRIBUTION %																		
MAGS	35.5	17.2	23.7	43.2	16.7	20.7	35.0	36.9	25.2	35.8	44.7	39.8	27.3	60.5	27.6	46.4	22.4	
NON-MAGS	64.5	82.8	76.3	56.8	83.3	79.3	65.0	63.1	74.8	64.2	55.3	60.2	72.7	39.5	72.4	53.6	77.6	
GAUDIN SELECTIVITY INDEX COMBUSTIBLE (100-Ash-1.6 S)	2.0	3.7	2.7	2.7	3.7	3.8	3.8	2.8	4.5	4.5	3.8	2.6	3.0	0.6	3.2	2.8	4.2	

CANMET
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Appendix 1

CHANGES NOTED ON TESTS

TEST NUMBERS

17, 23, (29), 31, 32, 40, 41, 46, 49, 50, 56, 57, 62, 63, 69, 76, 84, 85, 88, 91, 97, 98, 99, 100, 101, 102, 104, 123, 124, 125, 126, 127, 128, 133, 135, (135), (136), (137), (138), (139), (140), 130, 131

The listed tests have been changed. Either the test number, ( ), has been changed because of errors in the original data set, or the data has been modified from the values supplied by CANMET. Data modification has been only to reach agreement with the original data set or to correct calculated results which may have been transposed or otherwise misstated.

A P P E N D I X

Capital and Operating Costs

Using the following assumptions:

Feed coal 20% Ash, Product 10% Ash, volumetric loading 5%, retention time of .25 minutes, flushing time 5 minutes, 2.0 Tesla.

For 100 TPH of coal at 40% solids, approximately 35 84" diameter canister HGMS are required. Capital costs are therefore on the order of $700,000/TPH with power requirements of 2100 KW which is obviously uneconomical.

The equipment sizing, however, is significantly effected by the large amount of magnetics to be removed and the loading. If the majority of the ash could be removed by more conventional methods, or perhaps permanent magnetic roll type separators, the economics for the use of HGMS would be greatly improved. The test results indicated that the volumetric loading could have been increased somewhat with some reduction in selectivity. If the loading could be increased to 30% by volume and the amount of magnetics to be removed reduced to 5%, the number of 84" diameter Superconducting HGMS units required is reduced to two. This equates to a capital cost of $40,000/TPH of coal treated and power requirements of 120 KW.